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ANTHRAX OUTBREAK

in Oklahoma, 1957

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service ■ August 1958

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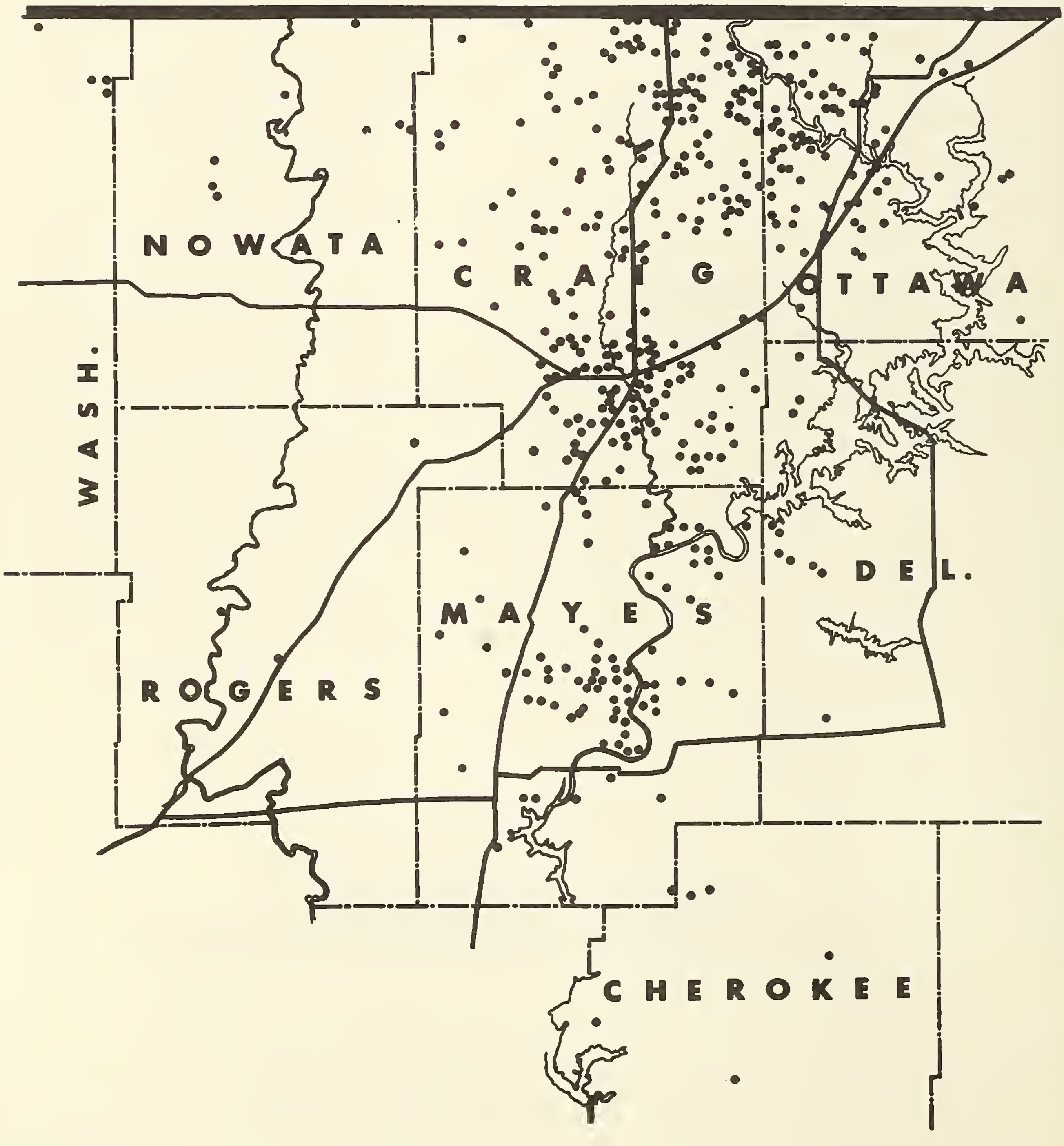
Prepared by

Animal Disease Eradication Division
Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

ANTHRAX REPORTED

Oklahoma, 1957



ANTHRAX OUTBREAK IN OKLAHOMA, 1957

This report is based on data collected mainly from three counties in the northeastern corner of Oklahoma, namely Craig, Ottawa, and Mayes Counties, in 1957. Although the report does not give a complete record of all premises involved or deaths reported for the entire State, it nearly does so, as the greater part of the outbreak took place in the three counties studied. Included are a series of 11 tables and, for each of the counties, 4 graphs. These are the basis for the report. The graphs for Craig, Ottawa, and Mayes Counties (Figs. 1-3) show daily rainfall, daily maximum and minimum temperatures, onset of anthrax in premises by date, and vaccination of herds by date.

DESCRIPTION OF COUNTIES

Craig County consists mainly of rolling prairie land with a few areas of hilly country. In the northwest and along the western edge there is higher land. Drainage along the west face of these hills is through Big Creek. East of this higher ground the land slopes toward the south. There are hills also in the southwestern part of the county and in the southeast corner. Drainage for the greater part of Craig County is through branches of the Big Cabin Creek, which goes south into Mayes County to empty into the Grand River near Pensacola.

Mayes County is divided into two parts by the Grand River. East of the river is a rocky section, a continuation of a similar area in the southeast corner of Craig County. This rocky section comprises the foothills of the Ozarks to the east. The section slopes westward toward the Grand River. To the west of the Grand River is an area of open prairie country gently sloping toward the river.

Ottawa County, in the extreme northwest, is also divided by the Grand River. East of the river the terrain slopes upward to some extent and tends toward hills and timber. West of the river the terrain is similar to the rolling prairies of Craig County.

The three-county area tends to form a rough trough, with higher ground along the western edge, a lower center section, and higher elevations along the east side. Throughout the area the land slopes irregularly toward the south.

Elevations along the west edge of Craig County run over 1,000 feet above sea level in the northwest corner; and those of the white oak hills in the southwest corner run about 900 feet. In eastern Craig County the elevation at Welch is 840 feet, at Blue Jacket, 780 feet, and at Vinita, 700 feet. Big Cabin Creek crosses from Craig County into Mayes County at an elevation of 650 feet. In Mayes County the west edge runs to elevations of about 950 feet. In western Mayes County at Adair, the elevation is 650 feet and at Pryor, 625 feet. Mayes County's eastern edge has an elevation of about 1,150 feet. In Ottawa County, Miami, which is directly east of Welch, in Craig County, has an elevation of 773 feet. Miami is west of the Grand River and about in the center of the western portion of the county. The eastern edge of Ottawa County is hilly and of higher elevation than the western part.

General farming is common throughout the area. Livestock is raised in conjunction with farm crops; the livestock are raised to make use of grazing land and the wild hay growing in the area. The cattle raised are mainly beef breeds.

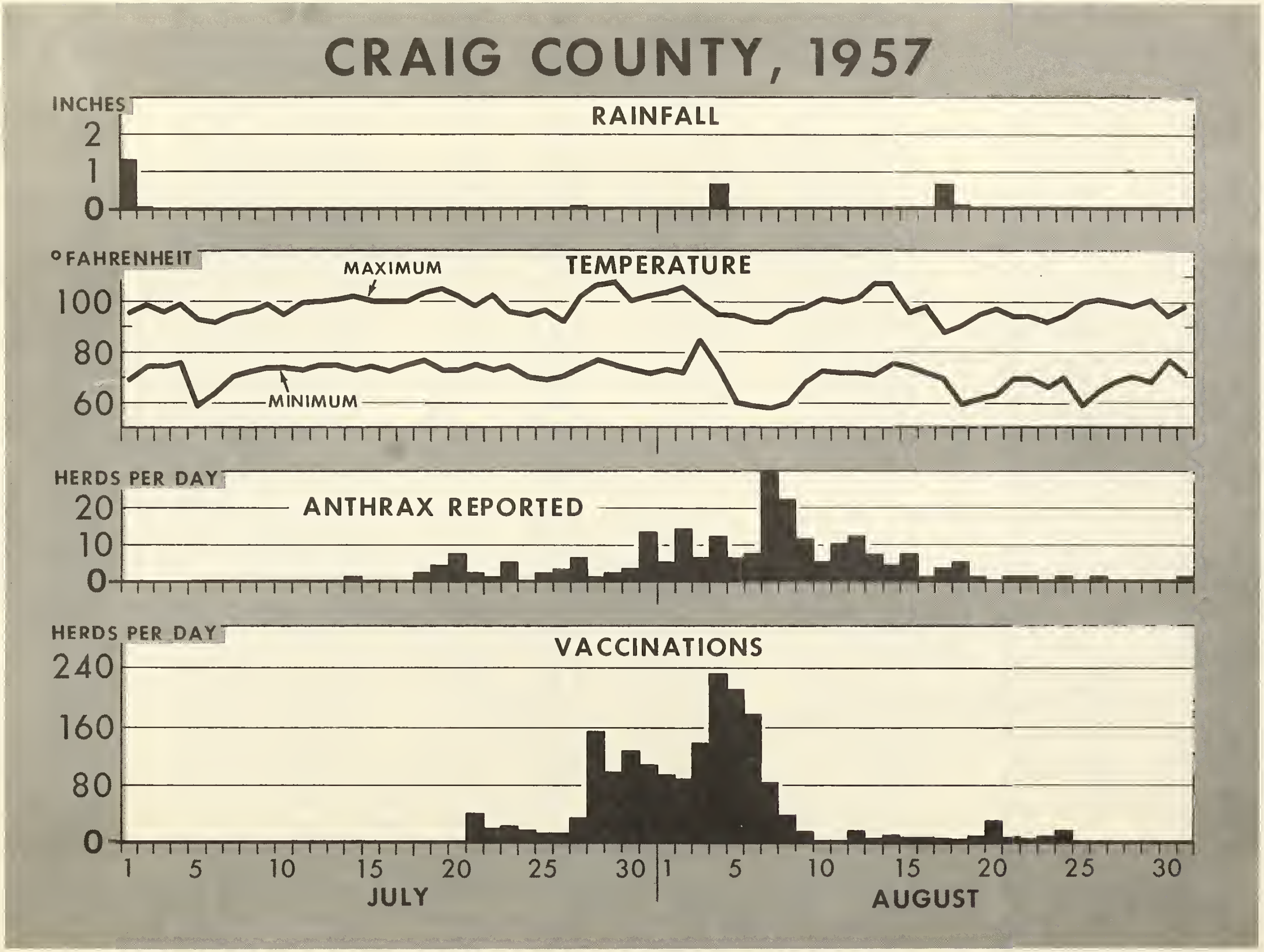


Figure 1. --Craig County daily rainfall, temperature, onset of anthrax on premises, and vaccinations of herds for July and August 1957.

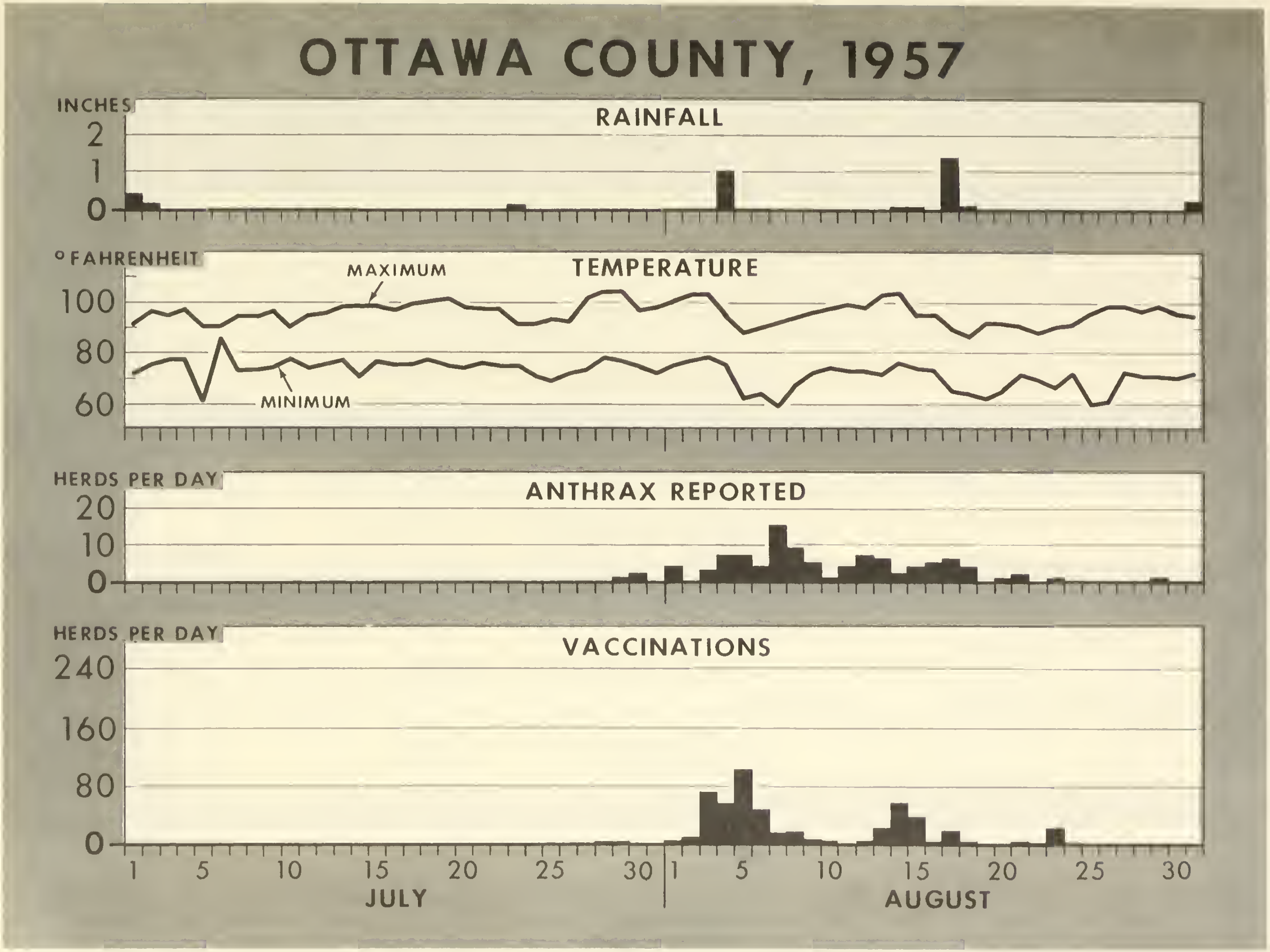


Figure 2. --Ottawa County daily rainfall, temperature, onset of anthrax on premises, and vaccinations of herds for July and August 1957.

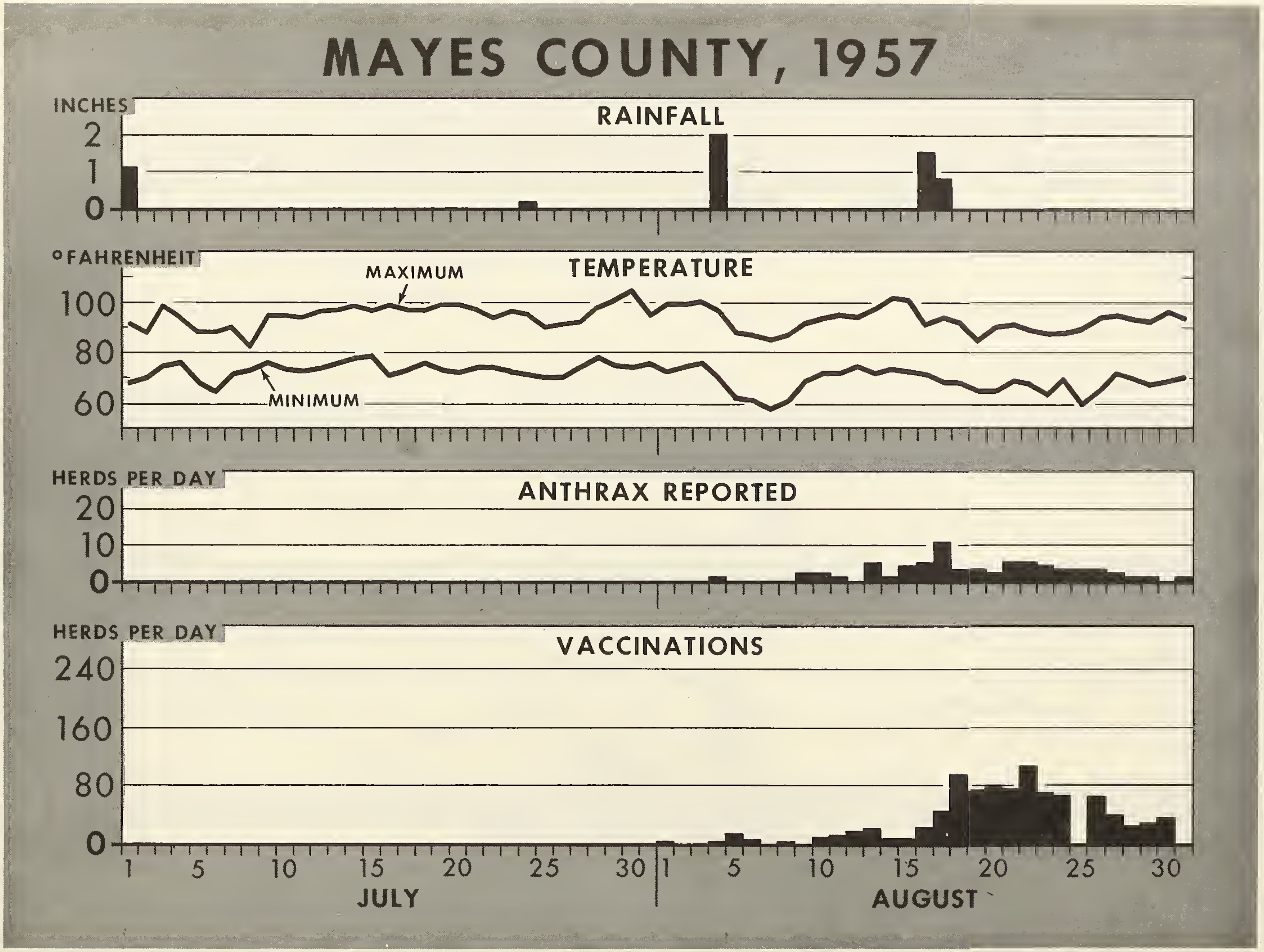


Figure 3.--Mayes County daily rainfall, temperature, onset of anthrax on premises, and vaccinations of herds for July and August 1957.

DRAINAGE AND RAINFALL OF AREA

Water sources for livestock are mainly farm ponds and streams. Dams are built along watersheds throughout the area and store water which would normally be lost by drainage out through streams. Drainage throughout the area is generally very good. The upland areas are drained by a network of streams which are usually dry but which provide drainage during heavy rains. There are a few flat areas where drainage is not very good. The hilly sections have no drainage problem, owing to steep slopes and soils which do not tend to retain moisture readily.

There are two flood-control dams along the Grand River. One is located below Mayes County and the other near Disney in Mayes County. Both dams form artificial lakes and are used to retain excess water during flood periods. During periods of heavy rains or floods in areas to the north, both of these lakes tend to back up along the bottomlands and into the streams that normally drain the surrounding areas. When these lake levels are high, the three counties have low areas which are likely to be flooded.

Following several years of below-normal precipitation, the spring of 1957 produced heavier than normal amounts of rainfall. Table 1 gives the monthly precipitations and deviations from normal recorded for the three counties for the years 1955 and 1956, and through August 1957. Craig County normally has approximately 43 inches of precipitation annually; from the table it can be seen that in 1955 it received 12 inches less than normal and in 1956 it received 15.73 inches less. By the end of June 1957, Craig County had already received a total of 43.56 inches. This constitutes the normal rainfall for a year. Most of it fell during April, May, and June; 36.54 inches fell during this 3-month period. A similar situation existed in Ottawa and Mayes Counties. Ottawa County had an excess of 11.48 inches for the 3-month period and Mayes had an excess of 18.23 inches.

The excess rainfall before July in 1957 was generally spread out over an extended period, hours or days. Craig County had 14 days when it rained during May, and 15 days were recorded in June. With the rains extended as they were, the ground absorbed water to a point of saturation. Slight depressions and flat areas which normally do not retain water had water standing over their surfaces. Normal drainage systems were filled, resulting in overflowing in some low areas. In addition, the flood control dams were holding water. This added to the upstream congestion.

In July the rains stopped. Rainfall was recorded on July 1 in all three counties. (See Figs. 1-3). Craig and Ottawa Counties recorded slight amounts of rainfall on July 2. This rainfall was the last until the latter part of the month. Temperatures were high, and rapid drying took place. During this drying period the first case of anthrax in this outbreak occurred near Welch in Craig County on July 14.

Table 2 gives a record of 1957 daily rainfall in the three counties for June, July, August, and a part of September.

TEMPERATURE OF AREA

The temperatures throughout July were generally high. Table 2 gives a record of 1957 daily maximum and minimum temperatures in the three counties for June, July, August, and a part of September; figures 1 to 3 show the maximums and minimums in graph form for July and August. In Craig County, the maximum daily temperature ranged from 92° to 107° F. with a mean of 98.87°; the minimum temperature ranged from 59° to 77° with a mean of 72.58°. In Ottawa County the maximum temperature ranged from 90° to 104° with a mean of 96.41°; the minimum temperature ranged from 61° to 86° with a mean of 74.45°. In Mayes County the maximum temperature ranged from 83° to 105° with a mean of 94.80°; the minimum temperature ranged from 64° to 79° with a mean of 73.19°.

During August temperatures continued to remain high. In Craig County the mean maximum and minimum temperatures were 97.67° and 69.35° F., respectively. In Ottawa

TABLE 1.--Total precipitation and departure from normal for Craig, Ottawa, and Mayes Counties, 1955, 1956, and January Through August 1957

County and year	Jan.		Feb.		March		April		May		June	
	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.
Craig Co. (Vinita)												
1955	0.49	-1.59	2.93	+1.19	3.11	+0.01	2.17	-2.25	5.90	+0.24	3.82	-1.94
1956	.78	-1.31	1.08	-.95	.91	-1.88	4.74	.49	5.44	-.51	3.70	-2.25
1957	1.22	-.87	2.72	+.69	3.08	+0.29	10.51	+6.26	14.23	+8.28	11.80	+5.85
Ottawa Co. (Miami)												
1955	.61	-1.43	3.77	+2.24	3.27	+.29	1.32	-3.17	5.66	+.57	7.95	+2.20
1956	1.01	-.83	.68	-1.35	.55	-2.18	4.48	+.45	6.51	+.81	4.66	-.65
1957	1.43	-.41	2.53	+.50	3.14	+.41	7.15	+3.12	11.57	+5.87	7.80	+2.49
Mayes Co. (Pryor)												
1955	.69	-1.65	2.77	+.94	2.06	-.36	2.10	-2.69	4.44	-1.10	3.61	-2.60
1956	.94	-1.19	1.37	-.89	1.21	-1.51	1.80	-2.50	7.49	+2.23	3.53	-1.56
1957	2.22	+.09	1.74	-.52	2.98	+.26	7.93	+3.63	14.52	+9.26	10.43	+5.34

County and year	July		Aug.		Sept.[1]		Oct.		Nov.		Dec.		Annual	
	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Precip.	Depart.	Total	Deviat.
Craig Co. (Vinita)														
1955	1.69	-1.87	4.46	+0.61	3.50	-0.80	3.56	-0.50	0.03	-2.94	0.32	-2.16	31.98	-12.00
1956	1.44	-1.62	2.37	-1.26	.19	-4.90	3.04	-.80	2.56	-.02	1.86	-.23	28.11	-15.73
1957	1.33	-1.69	1.33	-2.25										
Ottawa Co. (Miami)														
1955	.92	-2.14	5.91	+2.35	3.69	-1.17	2.94	-1.81	.00	-2.96	.89	-1.28	36.93	-6.31
1956	3.97	+1.22	1.55	-1.76	.24	-4.55	2.45	-1.36	3.88	+1.53	2.20	+.29	32.18	-8.38
1957	.69	-2.01	2.76	-.53										
Mayes Co. (Pryor)														
1955	.66	-2.32	5.85	+2.70	2.26	-2.99	3.27	-1.44	.15	-2.80	.51	-1.62	28.37	-15.93
1956	1.73	-1.09	1.17	-2.14	.47	-3.67	3.26	-.67	2.33	-.19	2.44	+.63	27.74	-12.55
1957	1.27	-1.51	4.32	+.99										

TABLE 2.--Daily rainfall and maximum and minimum daily temperature for Craig, Ottawa, and Mayes Counties, June-September 1957

CRAIG COUNTY

Date	JUNE			JULY			AUGUST			SEPTEMBER		
	Temp. °F		Inch rain	Temp. °F		Inch rain	Temp. °F		Inch rain	Temp. °F		Inch rain
	Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
1........	82	66	0.19	96	69	1.28	103	73		100	69	
2........	69	57	1.23	99	75	.02	105	72		103	75	
3........	85	60	.21	96	75		100.5	85		101	55	
4........	85	62	.17	99	76		95	74	0.65	98	63	
5........	89	64		93	59		94	60		94	65	
6........	91	65		92	64		92	59		88	64	0.22
7........	90	67		95	70		92	58		70	58	
8........	90	70		96	72		96	60		82	49	
9........	94	67	.22	99	74		98	68		84	51	
10........	88	64	3.53	95	74		101	73		87	55	
11........	90	75	.02	99	73		100	72		79	66	
12........	83	65		100	75		101	72		80	60	1.28
13........	89	67	2.04	101	75		107	71		89	58	.12
14........	84	70		102	73		107	75		80	60	
15........	89	68	1.98	100	74		96	74		79	63	.73
16........	90	72		100	72		98	72				
17........	91	74		100	75		88	69	.65			
18........	87	67	.07	103	76		90	59	.03			
19........	88	55		105	73		95	61				
20........	90	60		102	73		97	63				
21........	88	70		98	75		94	69				
22........	88	64	.79	102	73		94	69				
23........	86	59	.03	96	75		92	66				
24........	85	52	1.23	94	70		95	70				
25........	85	57		96	69		100	59				
26........	89	68	.02	92	70		101	65				
27........	85	65		102	74	.03	100	68				
28........	91	68		106	77		98	70				
29........	92	68		107	75		101	68				
30........	95	73	.07	100	73		94	77				
31........	-	-		102	72		98	72				
Mean Temp.	87.60	65.30		98.87	72.58		97.67	69.35		87.60	60.73	

OTTAWA COUNTY

1........	82	67	0.32	91	72	0.42	100	75		96	70	0.23
2........	69	56	.73	96	76	.17	103	77		98	76	
3........	74	62	.44	95	77		103	78		100	57	
4........	84	67	.08	97	77		95	75	1.00	93	63	
5........	87	67		90	61		89	62		90	65	
6........	89	67		90	86		90	64		85	63	.53
7........	89	68		94	73		92	59		76	57	.17
8........	89	71		94	73		94	67		79	51	
9........	86	67	1.94	96	74		96	72		83	53	
10........	86	65	.88	90	77		98	74		85	61	
11........	90	75	.18	95	74		99	73				

TABLE 2.--Daily rainfall and maximum and minimum daily temperature for Craig, Ottawa, and Mayes Counties, June-September 1957--Continued

Date	JUNE			JULY			AUGUST			SEPTEMBER		
	Temp. °F Max.	Temp. °F Min.	Inch rain	Temp. °F Max.	Temp. °F Min.	Inch rain	Temp. °F Max.	Temp. °F Min.	Inch rain	Temp. °F Max.	Temp. °F Min.	Inch rain
OTTAWA--Continued												
12........	87	68		96	76		98	73				
13........	86	67	0.83	98	77		103	72				
14........	85	74		99	70		104	76	0.04			
15........	87	70	.31	98	76		95	74	.04			
16........	88	73		97	75		95	73				
17........	90	75		99	75		89	65	1.40			
18........	88	68	.02	100	77		87	64	.05			
19........	85	58		101	75		92	62				
20........	88	65		98	74		92	65				
21........	88	72		97	76		91	72				
22........	86	65	.80	97	75		88	69				
23........	83	60		91	75	.10	90	66				
24........	83	55	.73	91	71		91	72				
25........	83	62		93	69		96	60				
26........	81	71		92	72		99	61				
27........	85	69		101	73		99	73				
28........	90	67	.26	104	78		97	71				
29........	91	73		104	77		99	71				
30........	93	72	.28	97	75		96	70				
31........	-	-		98	72		95	72	.23			
Mean Temp.	75.06	67.10		96.41	74.45		92.64	69.51		88.50	61.60	
MAYES COUNTY												
1........	85	65	0.27	91	68	1.10	99	73		94	60	0.42
2........	70	60	2.86	88	70		99	74		94	70	
3........	65	60	.25	99	75		100	76		94	57	
4........	73	62	.22	94	76		97	70	2.00	95	65	
5........	84	63	.12	88	68		88	62		95	64	
6........	87	64	.34	88	64		87	61		96	62	.63
7........	88	68		90	72		85	58		84	60	.03
8........	89	70		83	73		87	61		66	52	
9........	89	70		95	76		92	69		77	51	
10........	91	65	1.00	95	74		94	72		80	55	
11........	88	65	.03	94	73		95	72		83	63	
12........	90	70		96	74		94	75		77	60	.85
13........	82	65	.72	97	76		97	72				
14........	86	71		99	78		102	74				
15........	85	68	2.46	97	79		101	73				
16........	88	70		99	71		91	72	1.49			
17........	88	74		97	73		94	68	.83			
18........	89	68		97	76		92	68				
19........	82	58		99	73		85	65				
20........	84	65		99	72		90	65				
21........	87	71		97	74		91	69				
22........	87	64	.35	94	74		89	68				

TABLE 2.--Daily rainfall and maximum and minimum daily temperature for Craig, Ottawa, and Mayes Counties, June-September 1957--Continued

Date	JUNE			JULY			AUGUST			SEPTEMBER		
	Temp. °F		Inch rain	Temp. °F		Inch rain	Temp. °F		Inch rain	Temp. °F		Inch rain
	Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
MAYES COUNTY--Continued												
23........	84	64		96	72		88	64				
24........	77	53	1.76	95	71	0.17	88	70				
25........	82	57		90	70		89	60				
26........	83	65		91	70		94	65				
27........	82	66		92	74		95	72				
28........	88	69		98	78		94	70				
29........	90	71		101	75		93	67				
30........	92	74	.05	105	74		96	69				
31........	-	-		95	76		94	70				
Mean Temp.	84.50	62.73		94.80	73.19		92.90	68.51		86.25	59.91	

County the mean maximum and minimum temperatures were 92.64° and 69.51°, respectively. In Mayes County the mean maximum and minimum temperatures were 92.90° and 68.51°.

In September temperatures were high at the beginning of the month but started becoming lower.

EXTENT OF OUTBREAK

Table 3 presents the dates on which anthrax was reported to have occurred in eight counties (July, August, and September); Figures 1-3 show the extent of outbreak graphically for Craig, Ottawa, and Mayes Counties (July and August). The table indicates the number of new herds (premises) on which anthrax was diagnosed. The extent and location of the outbreaks in northeastern Oklahoma are shown by the illustration inside the front cover.

It may be seen from this table and the graph of Figure 1 that Craig County first had an occurrence of anthrax on July 14. Outbreaks at new premises occurred from July 14 until September 6. A total of 229 premises were reported during this period. The largest number of premises with infected herds on any one date was 30, occurring on August 7. During an 11-day period August 2 through August 12, 135 (60%) of the infected herds were reported.

In Ottawa County anthrax was reported from July 29 until September 11. During this period 105 premises were involved, with the peak occurring on August 7 (15 premises). Sixty-two premises (approximately 60%) were reported for an 11-day period August 3 through August 12.

In Mayes County new premises were reported from August 4 through September 10. Seventy-seven premises were involved with 44 (57%) reported from August 13 through

TABLE 3.--Herds infected with anthrax (premises reported) by date of onset in eight counties, July-September 1957

Month and day	COUNTIES							
	Craig	Ottawa	Mayes	Delaware	Washington	Nowata	Rogers	Cherokee
July								
14............	1	-	-	-	-	-	-	-
15............	-	-	-	-	-	-	-	-
16............	-	-	-	-	-	-	-	-
17............	-	-	-	-	-	-	-	-
18............	2	-	-	-	-	-	-	-
19............	4	-	-	-	-	-	-	-
20............	7	-	-	-	-	-	-	-
21............	2	-	-	-	-	-	-	-
22............	1	-	-	-	-	-	-	-
23............	5	-	-	-	-	-	-	-
24............	-	-	-	-	-	-	-	-
25............	2	-	-	-	-	-	-	-
26............	3	-	-	-	-	-	-	-
27............	6	-	-	-	-	-	-	-
28............	1	-	-	-	-	-	-	-
29............	2	1	-	-	-	-	-	-
30............	3	2	-	-	-	-	-	-
31............	13	-	-	-	-	-	-	-
August								
1............	5	4	-	-	-	-	-	-
2............	14	-	-	-	-	-	-	-
3............	6	3	-	-	-	-	-	-
4............	12	7	1	-	-	-	-	-
5............	6	7	-	-	-	-	-	-
6............	7	4	-	-	-	-	-	-
7............	30	15	-	1	-	-	-	-
8............	22	9	-	-	-	-	-	-
9............	11	5	2	-	-	-	-	-
10............	5	1	2	-	-	-	-	-
11............	10	4	1	-	-	-	-	-
12............	12	7	-	-	-	-	-	-
13............	7	6	5	-	-	-	-	-
14............	4	2	1	1	-	-	-	-
15............	7	4	4	-	2	-	-	-
16............	1	5	5	-	-	-	-	-
17............	3	6	11	-	-	-	-	-
18............	5	4	3	-	-	-	-	-
19............	1	-	3	-	-	-	-	-
20............	-	1	2	-	-	-	-	-
21............	1	2	5	-	-	-	-	-
22............	1	-	5	-	-	2	-	-
23............	-	1	4	-	-	1	-	-
24............	1	-	3	-	-	-	-	-
25............	-	-	3	-	-	-	-	-
26............	1	-	3	2	1	-	-	-
27............	-	-	2	3	-	1	-	-
28............	-	-	1	-	1	-	-	-
29............	-	1	1	-	-	-	1	-
30............	-	-	-	-	-	-	-	-
31............	1	-	1	-	-	1	-	-

TABLE 3.--Herds infected with anthrax (premises reported) by date of onset in eight counties, July-September 1957--Continued

Month and day	COUNTIES							
	Craig	Ottawa	Mayes	Delaware	Washington	Nowata	Rogers	Cherokee
September								
1............	-	-	2	1	-	-	-	-
2............	1	-	2	-	-	1	-	-
3............	2	-	1	-	-	1	-	-
4............	-	-	1	1	-	-	1	1
5............	-	-	1	-	-	-	-	-
6............	1	1	-	-	-	-	-	-
7............	-	1	-	1	-	-	-	-
8............	-	-	1	-	-	-	-	1
9............	-	-	-	-	-	-	-	-
10............	-	-	1	-	-	-	-	-
11............	-	2	-	-	-	-	-	-
12............	-	-	-	-	-	-	-	-
13............	-	-	-	-	-	-	-	-
14............	-	-	-	-	-	-	-	-
15............	-	-	-	-	-	-	-	-

August 22. The largest number of premises reported for any one day occurred August 17, when 11 were reported.

A vaccination program began July 21 in Craig County. Vaccination was offered on a no-cost volunteer basis. Herds in which anthrax had been diagnosed and herds in the vicinity of infected herds were generally vaccinated. During the initial phase of this outbreak, 3,000 doses of a #2 spore vaccine were used. All later vaccinations were made by using the noncapsulated spore vaccine developed by Sterne.

VACCINATIONS AND MORTALITY

Table 4 summarizes herd vaccinations against anthrax on a daily basis for eight counties (July, August, and September); Figures 1-3 present the vaccinations visually for Craig, Ottawa, and Mayes Counties (July and August).

In Craig County, herds were vaccinated from July 21 through September 9. During this period 1,797 herds were vaccinated. The number of herds vaccinated per day increased to peak on August 4, when 230 herds were vaccinated. Eighty-seven percent (1,558) of the herds vaccinated in Craig County had been vaccinated by August 7. Vaccinations dropped off sharply after this date.

In Ottawa County, vaccinations began on July 28 and stopped on August 24. During this period 494 herds were vaccinated. Vaccinations in this county showed 3 distinct peaks, one on August 5, one on August 14, and one on August 23. Each of these peaks was part of a group separated from the others by days on which no vaccinations took place.

In Mayes County, 942 herds were vaccinated. Vaccinations started on August 1 and continued through August 30. Vaccinations were sporadic from August 1 until August 16; then the numbers increased sharply to a peak on August 22, when 106 herds were vacci-

TABLE 4.--Vaccination of herds[1] against anthrax on a daily basis in eight counties, July-September 1957

Month and day	COUNTIES							
	Craig	Ottawa	Mayes	Delaware	Washington	Nowata	Rogers	Cherokee
July								
14	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
21	38	-	-	-	-	-	-	-
22	16	-	-	-	-	-	-	-
23	21	-	-	-	-	-	-	-
24	16	-	-	-	-	-	-	-
25	11	-	-	-	-	-	-	-
26	11	-	-	-	-	-	-	-
27	30	-	-	-	-	-	-	-
28	153	1	-	-	-	-	-	-
29	94	1	-	-	-	-	-	-
30	124	-	-	-	-	-	-	-
31	116	-	-	-	-	-	-	-
August								
1	90	3	1	-	-	-	-	-
2	86	6	-	-	-	-	-	-
3	136	71	-	-	-	-	-	-
4	230	55	1	-	-	-	-	-
5	209	103	12	-	-	-	-	-
6	177	45	2	-	-	-	-	-
7	81	13	-	1	-	-	-	-
8	36	15	1	-	-	-	-	-
9	13	4	-	-	1	-	-	-
10	1	3	7	-	1	-	-	-
11	1	-	9	-	-	-	-	-
12	14	3	16	1	-	-	-	-
13	3	21	21	-	-	-	-	-
14	7	55	5	-	-	-	-	-
15	5	35	5	-	1	-	-	-
16	5	1	22	-	2	-	-	-
17	3	17	45	-	-	-	-	-
18	2	1	95	-	-	-	-	-
19	6	-	74	1	-	-	-	-
20	27	-	77	-	1	-	-	-
21	4	2	75	-	-	-	-	-
22	2	1	106	-	-	-	-	-
23	5	21	71	-	-	3	-	-
24	13	1	67	-	-	-	-	-
25	-	-	-	-	-	-	-	-
26	-	-	66	1	-	-	-	-
27	-	-	38	-	1	-	-	-
28	-	-	25	-	-	-	-	-
29	-	-	27	-	-	-	-	-
30	-	-	36	-	-	-	1	-
31	-	-	-	-	-	-	-	-

TABLE 4.--Vaccination of herds[1] against anthrax on a daily basis in eight counties, July-September--Continued

Month and day	COUNTIES							
	Craig	Ottawa	Mayes	Delaware	Washington	Nowata	Rogers	Cherokee
September								
1...........	-	-	-	-	-	-	-	-
2...........	-	-	-	-	-	-	-	-
3...........	1	-	-	-	-	2	1	-
4...........	2	-	-	-	-	-	-	1
5...........	-	-	-	-	-	-	-	-
6...........	6	-	-	-	-	-	-	-
7...........	1	-	-	-	-	-	-	-
8...........	-	-	-	-	-	-	-	-
9...........	1	-	-	-	-	-	-	-
10...........	-	-	-	-	-	-	-	-
11...........	-	-	-	-	-	-	-	-
12...........	-	-	-	-	-	-	-	-
13...........	-	-	-	-	-	-	-	-
14...........	-	-	-	-	-	-	-	-
15...........	-	-	-	-	-	-	-	-

[1] There were 16 and 38 additional herd vaccinations for Ottawa and Mayes Counties, respectively, for which the actual date of vaccination was not reported.

nated. The herds vaccinated decreased after this date, but the number of vaccinations remained fairly high until the last day of vaccination on August 30, when 36 herds were vaccinated.

Table 5 summarizes total anthrax vaccinations for all counties and species involved in the 1957 outbreak.

TABLE 5.--Total vaccinations recorded for 5 species in 8 counties, 1957

County	Herds	Cattle	Horses	Sheep	Swine	Dogs	All Animals
Craig...........	1,797	82,411	1,491	10,120	6,776	2,412	103,210
Ottawa..........	494	14,962	589	1,119	1,347	731	18,748
Mayes...........	942	36,221	900	2,402	3,048	1,262	43,833
Nowata..........	22	5,885	99	103	117	29	6,233
Delaware........	96	2,449	51	467	539	139	3,642
Washington......	10	480	12	0	33	7	532
Rogers..........	32	1,649	39	6	52	69	1,815
Cherokee........	62	951	56	12	169	133	1.321
TOTALS..........	3,455	145,008	3,237	14,229	12,081	4,782	179,334

Table 6 shows the deaths due to all causes by species for the three counties as they were reported.

Table 7 gives the time of the last death, from the date of vaccination, in 127 vaccinated herds. From this table it will be seen that deaths dropped off after the seventh day from vaccination. This 8-day interval may have had some effect on the cases reported for

TABLE 6.--Deaths from all causes reported by species, Craig, Ottawa, and Mayes Counties, 1957

Species	Craig County	Ottawa County	Mayes County	Total deaths	Percent of total deaths
Cattle..........	421	273	138	832	84.55
Horses..........	19	3	4	26	2.64
Sheep...........	108	0	0	108	10.97
Swine...........	8	8	1	17	1.72
Dogs............	0	0	1	1	.10
TOTALS........	556	284	144	984	99.98

TABLE 7.--Vaccinated herds with last death from anthrax occurring from 0 to 17 days after vaccination date, in 127 vaccinated herds, in Craig, Ottawa, and Mayes Counties, 1957

Days after vaccination	Herds vaccinated			Total herds vaccinated	Percent of 127 vaccinated herds
	Craig County	Ottawa County	Mayes County		
0..........................	1	3	1	5	3.93
1..........................	6	6	0	12	9.44
2..........................	5	1	5	11	8.66
3..........................	14	3	1	18	14.17
4..........................	2	4	6	12	9.44
5..........................	9	4	2	15	11.81
6..........................	8	2	2	12	9.44
7..........................	16	0	6	22	17.32
8..........................	4	1	1	6	4.72
9..........................	3	0	0	3	2.36
10.........................	2	1	1	4	3.14
11.........................	1	0	0	1	0.78
12.........................	0	1	0	1	0.78
13.........................	2	0	0	2	1.57
14.........................	2	0	0	2	1.57
15.........................	0	0	0	0	-
16.........................	0	0	0	0	-
17.........................	1	0	0	1	0.78
TOTAL.....................	76	26	25	127	99.91

Craig County. The graph for Craig County shows the bulk of vaccination was done before the peak number of cases was reported. The decrease in numbers of new cases might have been caused by vaccination.

In Table 8 herds which had death losses due to anthrax are grouped according to the number of deaths in the herd. From this table it can be readily seen that death losses were not great. The first 2 groups, with 1 and 2 deaths, accounted for 79.49% of the herds.

The low mortality rate is borne out in Table 9. The last section of the table summarizes losses for the three counties according to species and all animals regardless of species. Herds in which anthrax had been diagnosed had a mortality of 2.70%. The mortality was 0.59% when the deaths were figured against the total vaccinated population.

TABLE 8.--Herds reporting anthrax-caused deaths from 405 herds, in Craig, Ottawa, and Mayes Counties, 1957

Number of deaths in each herd	Herds			Total herds	Percent of 405 herds, in 3 counties	Total deaths	Percent of 984 deaths in 3 counties
	Craig	Ottawa	Mayes				
1...............	139	59	46	244	60.24	244	24.79
2...............	45	13	20	78	19.25	156	15.85
3...............	11	10	5	26	6.41	78	7.92
4...............	9	6	1	16	3.95	64	6.50
5...............	4	4	1	9	2.22	45	4.52
6...............	3	3	3	9	2.22	54	5.48
7...............	3	0	1	4	0.98	28	2.84
8...............	2	2	0	4	0.98	32	3.25
9...............	4	2	1	7	1.72	63	6.40
10..............	0	0	0	0	-	-	-
11..............	1	0	0	1	0.24	11	1.11
12..............	0	0	0	0	-	-	-
13..............	0	2	0	2	0.49	26	2.64
14..............	1	0	0	1	0.24	14	1.42
21..............	2	0	0	2	0.49	42	4.26
47..............	0	1	0	1	0.24	47	4.77
80..............	1	0	0	1	0.24	80	8.13
TOTALS.........	225	102	78	405	99.91	984	99.88

INFLUENCE OF TERRAIN AND WATER SOURCE

In Table 10 an attempt is made to determine the effects of terrain on death rates. Although the terrain classifications are probably too broad to be accurate, the table does indicate that on the premises the highest ratio of deaths per premise occurred where animals were in contact with both upland and bottom-land areas.

In Table 11 herds are classified by general terrain types and by water sources. The contrast here lies in the number of herds being watered from tanks and their low ratio of deaths per herd against the highest ratios in herds watering from ponds or rivers and streams.

One of the most common sources of water for livestock in this area is the farm pond. Out of 211 herds, 188 were using ponds alone or with other water sources. These ponds are situated in watershed areas and are made by erecting dams which hold runoff water. These ponds are possibly the source or development point for some of the anthrax appearing in this outbreak in that they are potential incubation spots for anthrax spores left from some past years.

As runoff water enters the pond, the suspended soil gradually settles out to form an alluvial deposit at the entrance to the pond. This deposit is similar to that found in rivers. It forms the potential incubation beds. The soil is usually rich, and when above water has a rich growth of vegetation on its surface.

During the spring of 1957 these ponds were filled to capacity for periods long enough to destroy the vegetation along the rims. This dead vegetation added to the media available for bacterial growth.

When the rains stopped after the first of July and higher temperatures became common, rapid drying occurred. The higher temperatures produced rapid evaporation and

TABLE 9.--Mortality for five species related to infected herds and total herds vaccinated, Craig, Ottawa, and Mayes Counties, 1957

CRAIG COUNTY

Item	Total premises	Species					Total all animals
		Cattle	Horses	Sheep	Swine	Dogs	
INFECTED HERDS REPORTING:							
Vaccinations............no.	232	16,272	236	3,629	1,109	292	21,538
Deaths..................no.	---	421	19	108	8	---	556
Mortality.............pct.	---	2.58	8.05	2.97	.72	---	2.58
TOTAL ANIMAL VACCINATIONS.no.	1,797	82,411	1,491	10,120	6,776	2,412	103,210
MORTALITY IN ALL VACCINATED HERDS..........pct.	---	.51	1.27	1.06	.11	---	.53
OTTAWA COUNTY							
INFECTED HERDS REPORTING:							
Vaccinations............no.	99	6,037	217	609	534	124	7,521
Deaths..................no.	---	273	3	---	8	---	284
Mortality.............pct.	---	4.52	1.38	---	1.49	---	3.77
TOTAL ANIMAL VACCINATIONS.no.	494	14,962	589	1,119	1,347	731	18,748
MORTALITY IN ALL VACCINATED HERDS..........pct.	---	1.82	.50	---	.59	---	1.51
MAYES COUNTY							
INFECTED HERDS REPORTING:							
Vaccinations............no.	73	6,790	122	44	272	88	7,316
Deaths..................no.	---	138	4	---	1	1	144
Mortality.............pct.	---	2.03	3.28	---	.36	1.13	1.95
TOTAL ANIMAL VACCINATIONS.no.	942	36,221	900	2,402	3,048	1,262	43,833
MORTALITY IN ALL VACCINATED HERDS..........pct.	---	.38	.44	---	.03	.07	.32
TOTAL THREE COUNTIES							
INFECTED HERDS REPORTING:							
Vaccinations............no.	405	29,099	575	4,282	1,915	504	36,375
Deaths..................no.	---	832	26	108	17	1	984
Mortality.............pct.	---	2.85	4.52	2.82	.88	.19	2.70
TOTAL ANIMAL VACCINATIONS.no.	3,233	133,594	2,980	13,641	11,171	4,405	165,791
MORTALITY IN ALL VACCINATED HERDS..........pct.	---	.62	.87	.79	.15	.02	.59

gradual warming of the soil. At some point during this drying cycle, alkaline solutions were being brought to the surface. In several instances, deposits of salts were found along the rims of ponds or in areas where pools had existed and had dried up. Similar deposits of these salts were seen in large amounts around pools in the mining areas in northern Ottawa County. Pools near chert piles had rims of salts which covered large areas. The salts were caused by the reaction of alkaline salts disolved from the chert piles with acids present in the soil.

TABLE 10.--Effects of terrain on death rates in Craig, Ottawa, and Mayes Counties, 1957

Item	Terrain			Total
	Upland	Bottomland	Combined	
Infected Premises				
Counties				
Craig	66	14	25	105
Ottawa	34	11	8	53
Mayes	39	11	3	53
Total	139	36	36	211
Percent of total	65.87	17.06	17.06	99.99
Death Losses on 211 Premises				
Counties				
Craig	124	45	153	322
Ottawa	96	95	23	214
Mayes	82	28	3	113
Total	302	168	179	649
Percent of total	46.53	25.88	27.58	99.99
Ratio of Deaths Per Premise, on 211 Premises				
Counties				
Craig	1.87	3.21	6.12	---
Ottawa	2.82	8.63	2.87	---
Mayes	2.10	2.54	1.00	---
Total	2.17	4.66	4.97	---

In general, soils in this northeastern area of Oklahoma are acid, ranging lower than a pH of 6.0, which is the minimum favorable pH for anthrax spores to multiply. During the drouth, evaporation of alkaline ground water increased the available basis in the soil. Immediately following the heavy rains of 1957, hot dry weather caused an increased evaporation rate which in some areas led to the accumulation of alkali on the surface of the soil and on the vegetation.

There are other areas as well as ponds and river bottoms that might be incubation areas. There are any number of flat, poorly drained areas and slight depressions which normally would not retain water for any period of time. Under the conditions existing in the spring of 1957 some of these areas were filled or flooded for different periods of time. These places could likewise provide the requirements for anthrax spores to multiply, assuming that they are present.

THE GENERAL PICTURE

No determination could be made as to the time required for spores to propagate and reach an infective level. In Craig County the first anthrax was diagnosed after 12 days without rain and temperatures not below 59° F. minimum and with maximum temperatures ranging from 92° to 102°. There had been other deaths on this premise before the diagnosis was made.

In Ottawa County the first premise had a similar picture. This group of cattle was placed on a small lot which had been flooded. No specific times were available, but the owner stated that these cattle were put on as soon as it got dry enough to support them. In 15 days anthrax was diagnosed. One animal had died on the eighth day and another on

TABLE 11.--Ratio of deaths per premise by terrain and water source for Craig, Ottawa, and Mayes Counties, 1957

Water Source	Craig County			Ottawa County			Mayes County		
	Upland	Bottom-land	Combined	Upland	Bottom-land	Combined	Upland	Bottom-land	Combined
PONDS									
Infected herds....................	41	5	8	30	4	6	23	4	---
Death losses......................	70	10	20	86	64	20	58	10	---
Ratio of deaths per premise.......	1.70	2.00	2.50	2.86	16.00	3.33	2.52	2.50	---
RIVERS									
Infected herds....................	1	2	---	---	1	---	5	3	---
Death losses......................	1	3	---	---	9	---	7	3	---
Ratio of deaths per premise.......	1.00	1.50	---	---	9.00	---	1.40	1.00	---
TANKS									
Infected herds....................	5	---	---	2	1	---	3	---	---
Death losses......................	5	---	---	5	1	---	4	---	---
Ratio of deaths per premise.......	1.00	---	---	2.50	1.00	---	1.33	---	---
PONDS, RIVERS, OR CREEKS									
Infected herds....................	13	6	15	---	4	---	6	4	3
Death losses......................	30	31	126	---	20	---	10	15	3
Ratio of deaths per premise.......	2.30	5.16	8.40	---	5.00	---	1.66	3.73	1.00
CREEKS, WELLS, TANKS, OR PONDS									
Infected herds....................	6	1	2	2	1	2	2	---	---
Death losses......................	18	1	7	5	1	3	3	---	---
Ratio of deaths per premise.......	3.00	1.00	3.50	2.50	1.00	1.50	1.50	---	---

the eleventh day. The owner thought these might have been due to anthrax. This period was one of high temperatures and very light rains.

A comparison of the temperatures as seen in Table 3 shows a similarity for the intervals preceding the first case in each of the three counties. The first reports were made on July 14 for Craig County, July 29 for Ottawa, and August 4 for Mayes. In each case temperatures had been in the 90° range, with a few days of temperatures 100° or above, just before these cases were reported. Minimum temperatures were almost entirely in the 70° range preceding each of these reports.

Generally animals were found dead. There were few instances in which owners observed symptoms before death. In herds where symptoms were noted, animals responded to antibiotic treatment when such treatment began early enough. It is probable that symptoms were usually missed because most of the cattle were in beef herds; there would not be the close inspection that is maintained in dairy herds.

The possibility of spread from herd to herd was considered. During the time of this outbreak, horseflies were very numerous. Dead carcasses usually showed streaks of uncoagulated blood running from the punctures made by the flies. There is a possibility that some spreading occurred within a herd from this means; but if it were an insect-borne spread, there should have been larger numbers of animals involved.

In two instances, animals were reported to have died following the ingestion of parts of carcasses of animals in which anthrax had been diagnosed. In one case, swine ate the tail and part of the udder from a cow dead of anthrax. These swine were reported to have died the next day. The other case was a horse which had been observed licking blood from a cow dead of anthrax. The horse had been vaccinated the day before this incident and died 4 days later.

The possibility of anthrax having been imported is slight. Most of the herds investigated were closed herds; cattle were moving out rather than coming in. This was the case at least for the three counties studied.

Two cases of anthrax in humans occurred. Both responded to antibiotic treatment. Both were the cutaneous form. One case involved a farmer and the other a veterinarian.

Throughout the general area of Mayes, Craig, and Ottawa counties most of the anthrax developed in the upland areas. It appeared there first, later in the bottom lands.

In the upland areas anthrax was generally associated with rolling prairie lands, where soils are fertile and have good water-retaining characteristics. These areas are associated with limestone and sandstone. Anthrax did not seem to occur in areas associated with shales.

In the bottom lands there are outcroppings of limestone and sandstone in some sections as well as the usual rich alluvial soils associated with bottom lands.

Anthrax seldom appeared in the rough hilly sections. In these the slopes are generally steep and rapidly drained. Soils here also tend to be poorer in water-retaining characteristics and generally are of lower fertility.

During years of normal rainfall anthrax in this northeastern area of Oklahoma could be expected to appear along the bottom land sections. The uplands, which apparently have been seeded with anthrax spores at some time in the past, would tend not to have an outbreak of this extent unless the rainfall and the temperature conditions during the spring of 1957 were repeated.

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